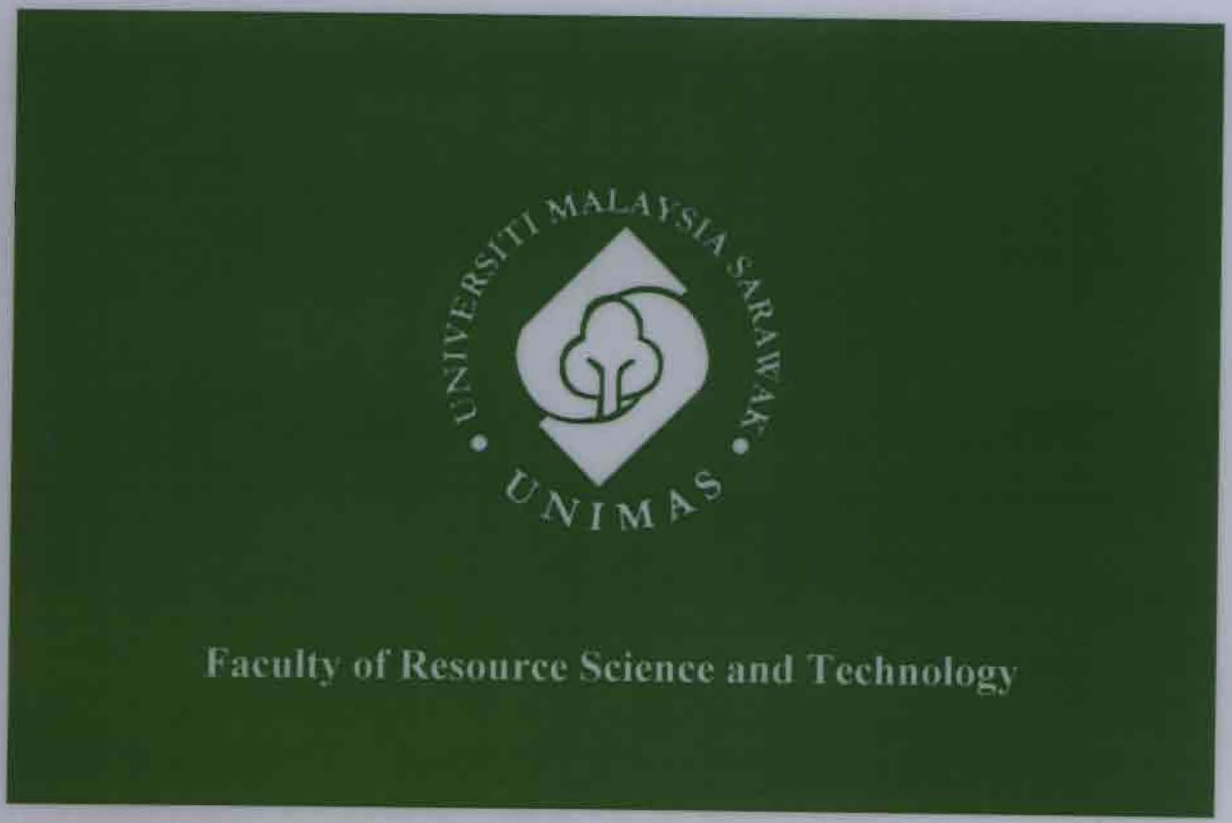

ASSESSING THE HEALTH STATUS OF TREES IN UNIMAS FOR SUSTAINABLE URBAN LANDSCAPE

Heida bt Mohamad Kamel

Master of Environmental Science
(Land Use and Water Resource Management)
2015

UNIVERSITI MALAYSIA SARAWAK

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Final Year Project Report ☐

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Assessing The Health Status of Trees in UNIMAS for Sustainable Urban Landscape

Heida binti Mohamad Kamel

A dissertation submitted in partial fulfillment of the requirements for the degree of

Master of Environmental Science (Land Use and Water Resource Management)

Faculty of Resource Science and Technology

UNIVERSITI MALAYSIA SARAWAK

2015

ACKNOWLEDGEMENT

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

Alhamdulillah, first of all I am grateful to be given the strength and good health to be able to complete my dissertation as part of my coursework. I would like to thank my supervisor, Dr Siti Rubiah bt Zainuddin, for without her words of wisdom it would have been impossible for me to complete my work and see trees and plants in a whole new perspective.

I would like to also thank my dearest friend, Dayang Zahidah Abg Mohd Othman for being with me through thick and thin, always there for me and giving me encouragement to complete my dissertation on time.

My highest gratitude goes to my parents, Hj. Mohd Kamel Hussein and Hjh. Johariah Zen, for understanding and encouragement, and also for sacrificing their time, enabling me to attend classes during this one and half year study at UNIMAS.

Finally, I dedicate this to my children, Siti Hajar, Muhd Ali Imran, Siti Maryam, Muhd Anas and Siti Aisyah, for they are the pillar of my strength and the force that drives me to complete studies.

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ABSTRACT

The existence of urban forests in the city plays an important role in providing numerous environmental, social and economic benefits to the people. Urban forests not only create an escape for the city dwellers from their hectic everyday life, it also helps to improve water and air quality, reducing flood, reducing heating and cooling energy needs, increasing the value of the property and enhancing the quality of life for people and wildlife around them. The main objective of this study was to assess and evaluate the health status of the selected trees species planted within Universiti Malaysia Sarawak (UNIMAS). A total of 328 trees from the species of *R. regia, A. heterophylla* and *Y. aloifolia* were assessed for their overall health status. The characteristics of the tree species planted and methods to improve their health problems were discussed so as to attain sustainable urban landscape.

Keywords : urban forests, health status, *R. regia, A. heterophylla, Y. aloifolia,* sustainability

ABSTRAK

Kewujudan hutan urban di dalam sesebuah bandar memainkan peranan yang penting dalam memberikan pelbagai kebaikan dari segi alam sekitar, sosial dan ekonomi. Hutan bandar bukan sahaja dapat mewujudkan ruang bagi penduduk bandar untuk lari dari suasana kehidupan harian yang sibuk, malah ia juga dapat memperbaiki kualiti air dan udara, mengurangkan banjir, mengurangkan keperluan tenaga bagi tujuan pemanasan dan penyejukan, menaikkan nilai hartanah and menambahbaik kualiti hidup manusia dan haiwan yang berada di sekitarnya. Tujuan utama kajian ini adalah untuk mengkaji dan menilai status kesihatan spesis pokok yang dipilih yang ditanam di sekitar Universiti Malaysia Sarawak (UNIMAS). Sejumlah 328 batang pokok dari spesis R. regia, A. heterophylla dan Y. aloifolia telah dinilai untuk tahap kesihatan keseluruhan. Ciri-ciri pokok yang ditanam dan kaedah untuk mengurangkan masalah yang dihadapi juga dibincangkan untuk memastikan lanskap urban yang lestari.

Kata kunci : Hutan urban, tahap kesihatan, R. regia, A. heterophylla, Y. aloifolia, kelestarian

CHAPTER 1

INTRODUCTION

1.1 Introduction

Trees are important for the sustainability of the environment. Without trees the most essential thing needed for human beings to continue living – oxygen – will not be produced. The ability of trees to process carbon dioxide into oxygen through the process of photosynthesis is essential because without oxygen human beings can no longer exist on this beautiful planet called earth.

Knowing the importance of trees, it not can only be found in forests but also it can also be found in cities, towns or a suburb. In the past, trees were often included in local plans primarily as beautification elements (Mcpherson & Geiger, 2005). But now, more people are starting to realize the important role that these urban trees play in maintaining human health and well being.

In UNIMAS itself, a huge amount of money was invested in planting trees all over the campus. These trees were mostly chosen based on their biological function. Among the trees that are planted within the campus are *Araucaria heterophylla* (Norfolk Island Pine), *Yucca aloifolia* (Spanish Bayonet), *Roystonea regia* (Cuban Royal Palm) and *Polyalthia longifolia* (Indian Mast Tree).

These trees played a very important role where each and every single tree provides different purposes. For example, the Cuban royal palms are being planted at

the entrance of UNIMAS, symbolizing a grand and majestic welcome to the visitors each time they enter the campus. The pine trees are planted at the roadside, giving beautiful and pleasant scenery at the roadside. In addition to the aesthetic values that urban trees provide, they also aid in erosion control, pollution removal, and rainfall interception.

Assessing the health status of these trees is important because it is essential for the sustainability of the urban environment. Winn et al. (2007) also mentioned that soil compaction, limited root growth, and groundwater contamination are a few factors that can influence tree health. By knowing the health status of urban trees, the management can plan ahead for maintenance aspect and prevent problems such as dieback, which can affect the sustainability of the urban trees in UNIMAS.

1.2 Problem Statement

Urban trees in UNIMAS play an important role because it not only gives an aesthetic value to the landscape, but also provides benefits in terms of health, environmental, economic and social aspects. These trees should be sustainable and beneficial on a long-term basis. However, some of these urban trees fail to serve their purpose probably due to factors such as diseases, poor soil condition and insufficient growing space. These factors will affect the sustainability of the urban trees and will cause problems such as an increase in the cost of maintenance. For this study, three (3) species were selected and analyzed for their health status. The species are *Araucaria heterophylla, Yucca aloifolia* and *Roystonea regia*.

1.3 Objectives

1. To evaluate the health status of selected tree species in UNIMAS
2. To find out what are the probable causes affecting the sustainability of selected tree species in UNIMAS

1.4 Significant Of Study

The significance of this study is to provide information on the health status of selected urban tree species in UNIMAS. This study can also be used to give recommendations on the best care and maintenance for the selected tree species to improve its life span and to ensure its sustainability.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Trees are important for the sustainability of human beings on earth. Nowadays trees are not only found in primary or secondary forest, but can also be found in cities, towns and suburbs and they are commonly known as urban forest. It provides the oxygen that we breathe, as well as other services that are essential to human beings. Oxygen production is one of the many environmental benefits that trees produce, and urban trees can produce a significant amount of oxygen (Nowak et al. 2007).

"Urban forestry is the management of trees for their contribution to the physiological, sociological, and economic well-being of urban society. Urban forestry deals with woodlands, group of trees, and individual trees, where people live – it is multifaceted, for urban areas include a great variety of habitats (streets, parks, derelict corners, etc.) where trees bestow a great variety of benefits and problems." (Grey & Deneke 1986).The management of trees and forests within urban areas is generally understood as urban forestry (Lee et al. 2004).

The emission of greenhouse gases - such as carbon dioxide, methane, ozone, chlorofluorocarbons - are one of the biggest factor contributing to the global warming threat (Casper 2010). Greenhouse gases specifically fossil fuel-based carbon dioxide emissions are increasing and the rise of these gases is expected to raise the global average temperate and cause other changes to the climate (Böhringer 2003). To

address the concern over the alarmingly increasing rate of global warming due to greenhouse gasses, the Kyoto Protocol was introduced in Kyoto, Japan in 1997. The aim of this protocol is to reduce the greenhouse gases emission by five percent below 1990 levels by industrialized countries within 2008 to 2012 (Rosser 2008).

The political environment surrounding urban vegetation has been altered and its value could increase due to the post-Kyoto protocol, although the Kyoto Protocol itself does not apply to urban vegetation (Moore 1997). This could be because it is believed that trees are able to contribute to mitigate global climate changes, due to their key role in the energy and mass exchanges between the atmosphere and the geosphere (Sieghardt et al. 2005).

2.2 Sustainability of Urban Forest

The Brundtland Report has made the concept of sustainability the center of attention for the international community where sustainable development was defined as 'meeting the requirements of present generation without compromising the ability of future generations to meet their own need' (Newton 2008). He also indicated that forest sustainability also became an international agenda after the statement of Forest Principles and Chapter 11 of Agenda 21 aims to ''contribute to the management, conservation and sustainable development of forests' and note the need for setting relevant standards for the forest use.

Clark et al. (1997) defined sustainable urban forest as:

"The naturally occurring and planted trees in cities which are managed to provide the inhabitants with a continuing level of economic, social, environmental and ecological benefits today and into the future."

He also listed a few criteria that should be fulfilled in order to achieve a sustainable urban forest. Among the criteria that should be considered are funding; staffing; assessment tools; species and site selection; and standards for tree care. To achieve sustainable urban forest, all these criteria must be met. Adequate funding can ensure a well-developed and well-maintained urban forest. Staffs and arborists that are well trained can increase an urban forest's sustainability.

By developing proper assessment tools, information about urban forest can be collected on a routine basis. Species and site selection are also important criterion because it is crucial to provide good planting sites and appropriate trees to fill them to ensure sustainability. The sustainability of urban forests also can be enhanced by adapting and adhering to professional standards for tree care such as Tree Pruning Guidelines. (Clark et al. 1997)

Carreiro et al. (2007) stated that the evolution of urban forestry has been recognized as an essential means of maintaining urban ecosystem health, improving human living conditions, fostering harmonious human-nature relationship and ultimately achieving urban sustainability. The main function of urban forest is to provide attractive environment for urban residents to live, work and spend the free

time (Konijnendijk 2005). However, urban forests also provide other types of benefits in terms of environmental, economical and social aspects.

2.3 Functions and Benefits of Urban Forest

Providing settings for physical exercise, reducing ultraviolet radiation and air pollution, and reducing stress are a few examples of the positive impacts that urban trees have on people's physical and mental health (Konijnendijk & Randrup 2004). There are many innovative projects organized around the idea of planting large number of trees, which aims to improve the quality of life and to increase ecological resilience. Urban forests not only give environmental benefits, but also benefits in economy and social aspects.

2.3.1 Environmental benefits of urban forest

2.3.1.1 Carbon sequestration

The process of keeping carbon dioxide - which contributes to the greenhouse effect that causes global warming - out of the atmosphere is known as carbon sequestration (Daniels 2010). Carbon dioxide is absorbed by trees, plants and crops through photosynthesis and stored as carbon in biomass in tree trunks, branches, foliage and roots and soils. This type of sequestration is the long-term storage of carbon in trees and plants, commonly referred to terrestrial sequestration (United States Environmental Protection Agency 2012).

According to Siry et al. (2005), forest carbon sequestration is one of the key approaches to reducing atmospheric carbon concentrations (Figure 2.1). It is a safe, environmentally acceptable, and cost-effective way to capture and store substantial amounts of atmospheric carbon. By sequestering carbon in new growth every year, trees will reduce the amount of carbon in the atmosphere and the amount of carbon annually sequestered is increased with the size and health of the trees (Clay et al. 2012).

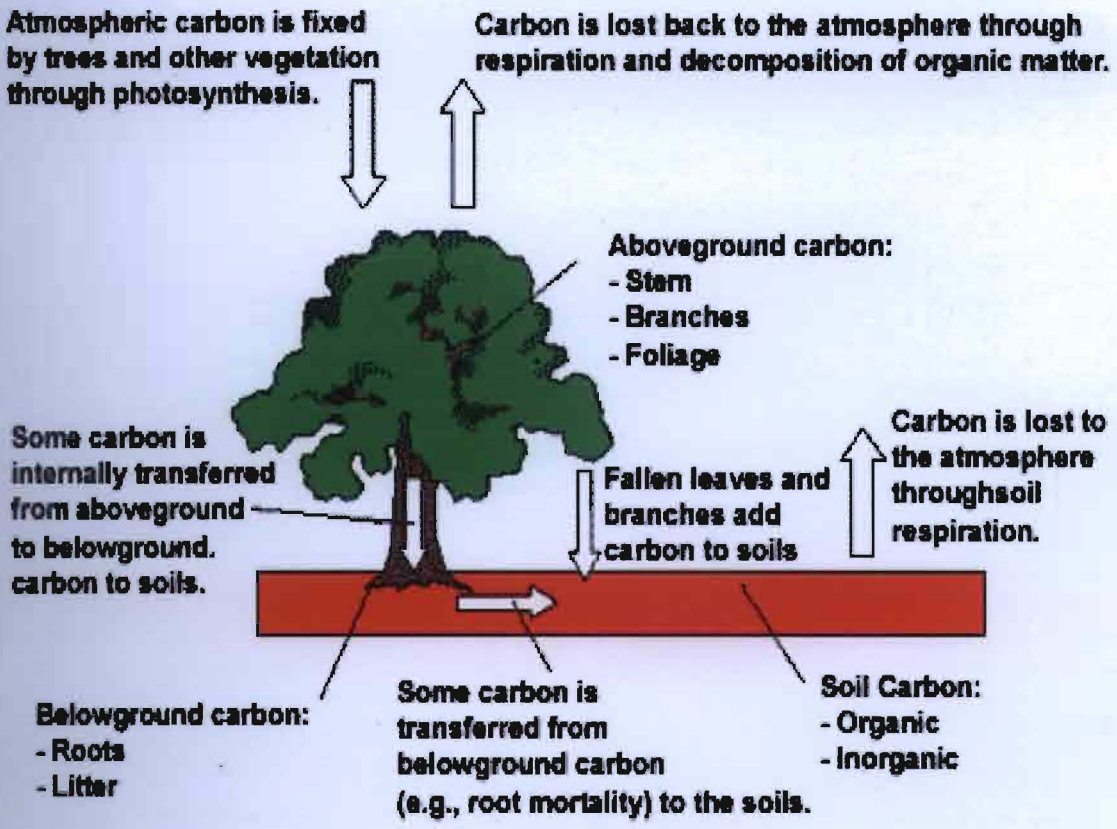

Figure 2.1 : Carbon sequestration cycle

Source : US Environmental Protection Agency (2012)

Natural forests have the highest ability to store carbon above ground due to their tremendous size and volume. Even though the urban forests will never be able to reach the same level as natural forests in carbon storing, it still plays an important role in reducing the atmospheric carbon through storage and sequestration (City of Boulder Water Conservation Office & Sherry 2002).

Although urban trees can help reduce the amount of carbon in the atmosphere, as they die and decay, they will release the stored carbon back to the atmosphere (Nowak 2007). Therefore it is important to ensure that the trees that are planted are well taken care of and sustainable to minimize the amount of carbon that is being released to the atmosphere when the trees decay and die.

2.3.1.2 Microclimate Regulation

Urban heat island (UHI) is a man-made area that exists because the land surface in towns and cities that are made from materials that absorbs and stores heat such as tarmac and stone. This area is significantly warmer than the surrounding countryside – especially at night (The Met Office 2012).

Voogt (2004) defined urban heat island as a way to describe the characteristic warmth of both the atmosphere and surfaces in cities (urban areas) compared to their nonurbanized surroundings, and the heat island is an example of unintentional climate modification when urbanization changes the characteristics of the Earth's surface and atmosphere.

By directly removing air pollutants and indirectly modifying microclimates through lowering temperature, and altering wind patterns, urban forests can influence local air quality (Escobedo 2013). A microclimate is a local atmospheric zone where the climate differs from the surrounding area. Georgi and Zafiriadis (2006) mentioned that a research was done Taha et al. (1988) to study the microclimate that was created under the tree foliage. The research showed that in the suburbs of Sacramento the air temperature under tree foliage is 1.7 to 3.3°C lower than the areas where there are no trees.

Urban forests can help to cool urban climates through shading and evapotranspiration. Carreiro et al. (2007) cited that urban forests could effectively modify the microclimate and improve thermal comfort in the summer through three mechanisms. By placing trees at suitable locations, it can prevent solar radiations from striking buildings and cooling the building at the same time.

Carreiro et al. (2007) also indicated the urban forests that are scattered throughout the city can act as windbreakers thus reducing the wind speed. Lower wind speed can reduce penetration of outside air into indoor space. Through evapotranspiration, urban forests can lower the summer air temperature where up to 378.5kg of water can be transferred into the atmosphere by an average mature tree through transpiration.

2.3.2 Economical benefits of urban forest

2.3.2.1 Energy Savings

Nowadays, more people are starting to realize the importance of saving and conserving energy in their daily life. By conserving energy that is used at houses or office buildings can reduce their monthly electricity bills. Not many people realize that planting trees at suitable locations can also help to help to conserve energy. The correct placement of trees can play a significant role in energy conservation where on a clear summer day, trees can block up to 70 to 90 percent of the sun's radiation and it can also reduce air conditioning demands by 10 to 30 percent (Whiting & O'Meara 2005).

Akbari (2002) stated that trees could conserve energy by acting as wind shielding or shelterbelts. Trees will lower the ambient wind speed by acting as windbreaks, which may lower or raise a building's cooling-energy use depending on its physical characteristics. However, energy conservation by trees are affected by regional climate, the size and amount of tree foliage, and the location of trees around buildings (Kuser 2006).

Trees that act as windbreakers reduce cold air infiltration into the building, thus reducing winter heating costs 20 to 40 percent. In the summer water evaporation from leaves will directly cools the air (Kuhns 2012). However, Kuhns (2012) also stated that there are a few design criteria to be followed for an effective windbreak design such as height, density, orientation, length and species of trees used.

Placing trees and shrubs near houses and buildings will provide shade thus reducing the need and demand of air conditioning. Solar heat that is absorbed by the active heat-absorbing surface of an inert building will be transferred to living foliage. Most of this energy will be transferred to the surrounding air because the heat capacity of leaves is low and water in the leaves will evaporate through evapotranspiration and air will be cooled (Mcpherson & Simpson 1995).

Without proper planning and design, urban trees that are planted at residential or commercial area cannot serve as their intended function for energy savings. The type of tree and the location must be taken into consideration for the design to work. Figure 2.2 shows the suitable trees and locations to be planted for efficient energy conservation. The hardiness of the particular plant, soil conditions, space and the site should be checked carefully when selecting plants to be planted as energy saving trees (van der Hoeven 1982).

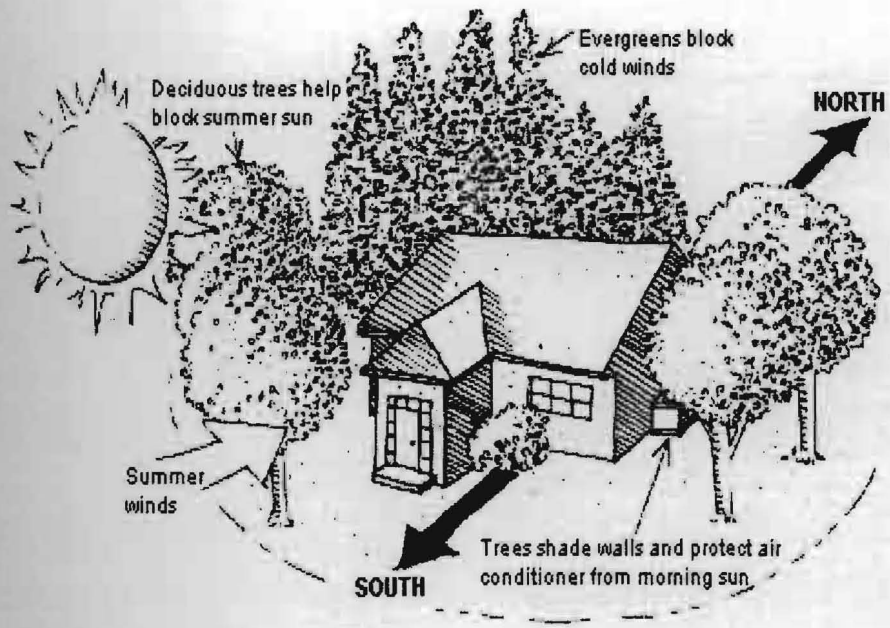

Figure 2.2 : Suitable tree location for energy conservation

Source : Walker & Newman (2009)